HOW TO CONTROL A GULLY

U.S. DEPARTMENT OF AGRICULTURE • FARMERS' BULLETIN NO. 2171

Preventing and controlling gullies is a vital part of soil and water conservation. Gullies can be prevented or controlled by following conservation practices described in this bulletin. These practices help to reduce soil erosion and sedimentation. At the same time, they help the farmer to increase the economic value of the land. Gullies are ugly; their prevention or control adds to the beauty of the countryside and to the enjoyment of the land by the farmer, his family, neighbors, and the rural community as a whole.

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Washington, D.C. Revised June 1973

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402—Price: 25 cents domestic postpaid, or 15 cents GPO Bookstore Stock Number 0100–02824

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Soil Conservation Service

Gullies occur throughout the United States. They are caused by the collection, in narrow channels, of water that removes the soil from the area to depths ranging from 1 or 2 feet to as much as 75 to 100 feet. Heavy rainfall, erodible soil, sloping land, soil that absorbs water slowly, and poorly managed vegetative cover are factors in determining the amount of gully erosion.

Gullies drain areas, rob soil of moisture, and reduce crop production. In advanced stages, gullies cut up fields or entire farms so crops can no longer be produced economically. Sediment from eroding gullies can accumulate on land and prevent its use for farming or other purposes. Streams become polluted from sediment. A sediment-filled stream channel can overflow from heavy rains and flood the surrounding land. Sediment also can clog pipes and cover railroad tracks and highways so that the cost of maintaining public services increases.

Some gullies have developed over the centuries through the process of natural or geologic erosion, but many are started or made larger by misuse of the land. As a farmer or rancher, you can do much to reduce gully erosion and sedimentation. The best way to control gullies is to prevent their formation.

You can obtain assistance from your local Soil Conservation Service (SCS) office in making a conservation plan to protect the land you farm against erosion. A system for disposing of excess water is necessary on all farms and ranches on which runoff occurs. The natural processes of erosion have created natural drainage patterns. The runoff from and within fields is collected in these natural drainageways and carried to main-stream channels. A conservation plan provides for using natural waterways to carry runoff and for shaping land where necessary to make water courses large enough to carry runoff at nonerosive velocities. This plan also provides for the maintenance of channels in grass. During the plowing and cultivation of adjacent fields, equipment is raised when crossing the waterways to avoid damaging the waterways or reducing their capacity. Grass seed and forage can be harvested from the waterways. Often cattle can graze on them.

The main drainageway on this 280-acre Illinois farm has been converted to a well-sodded grass waterway (ILL-2,100).

These conservation practices, if followed early enough, can reduce erosion and thus prevent gullies. Such prevention saves time and money, for the larger the gully and its drainage area, the more expensive and difficult it will be to control.

Once gullies have formed, however, certain conservation practices can stabilize them to serve as adequate water-disposal systems. These practices depend on the size of the gully and its drainage area. Gullies come in all sizes. A small gully is usually less than 8 feet deep, a medium gully 8 to 15 feet deep, and a large gully more than 15 feet deep. The drainage area—the area draining into a gully at any given point—also affects the kind of control. Drainage areas of less than 50 acres are considered small, 50 to 150 acres medium, and those greater than 150 acres large.

Small gullies with small to medium drainage areas can be improved and controlled by a farmer or rancher. Conservation practices used to control gullies follow.

FENCING AND REVEGETATION

One of the simplest and cheapest ways to control small and medium gullies having small drainage areas is to fence them and exclude livestock—a common procedure in areas that are badly gullied and cannot feasibly be restored to cropland. Build a fence around the area to be controlled. Place it far enough from the banks of the gully—a distance approximately equal to twice the gully depth—so that natural vegetation is restored. If revegetation

is slow, or if a special type of vegetation is desired, it may be necessary to seed the area. Grass, trees, or shrubs can be planted separately or in combination. Native grasses are best suited to gully plantings in most areas. A soil conservationist can help you in selecting the best vegetation for the area.

When a gully is planted, it may be necessary to do some bank sloping, particularly if the area is steep. Usually a satisfactory growth can be established without extensive sloping. If the gully is to be retired to woodlot or grass and stabilization is the primary factor, do only a minimum of bank sloping as needed.

DIVERSION OF RUNOFF

Water can be turned from a gully by diversions or terraces.

■ **Diversions.** A diversion is a channel or ditch and a ridge built across a slope to slow runoff and allow water to soak into the soil. The water flows slowly along the channel to a protected area or outlet channel. Diversions are limited to small drainages because of the difficulties in handling large volumes of water. They are best used for small gullies in pastures in which stable outlets are common. If the outlet is subject to erosion, the water should not be diverted. No advantage comes from diverting water from one gully if there is danger of forming another.

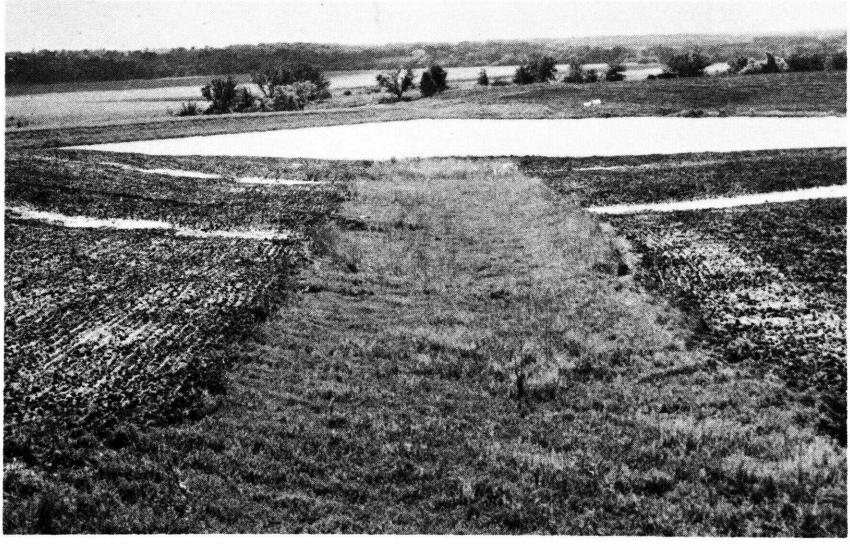
Fencing and natural revegetation control this pasture gully (NEB-497).

Areas above a diversion should be in grass or trees to reduce siltation in the channel. Diversions below cultivated fields can silt rapidly and create maintenance problems. Set a diversion upstream from the head of the gully a distance not less than three to four times the depth of the gully. It should be large enough to carry the runoff from the heaviest storm that is likely to occur about once in 10 years. A velocity of 4 to 6 feet a second normally protects the channel from erosion when a good stand of grass is established. A grade of 6 to 12 inches per 100 feet usually is safe. After water is diverted from a gully, natural revegetation often provides adequate control on the gullied area.

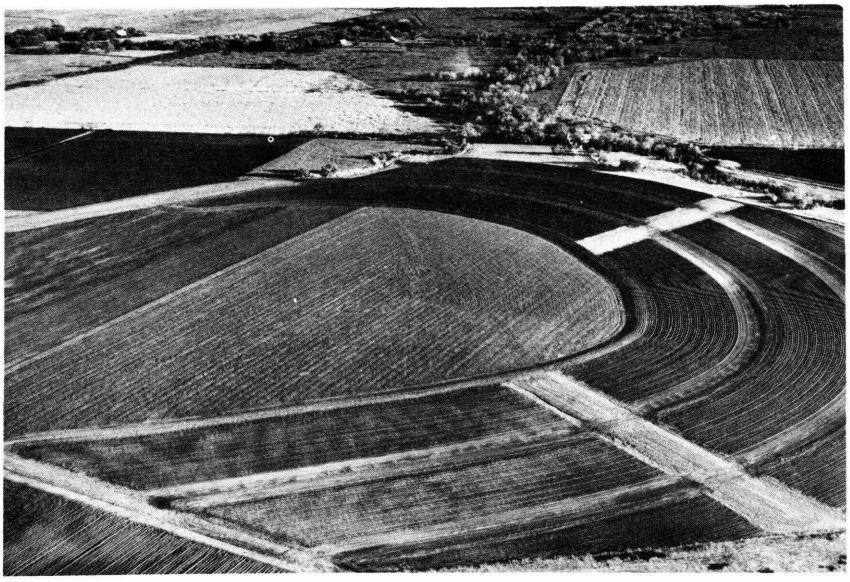
■ **Level terraces.** They are like diversions except they are usually smaller. Level terraces when properly spaced reduce runoff enough to control most gullies. Use level terraces in the major part of an area draining into a gully.

PONDS

Constructing stockwater ponds in range sections or pastures can help in gully control. They not only serve as a water supply but also can be welcome additions to family and community life by adding a touch of beauty to the landscape and bringing fun



A gully was converted to a grass waterway leading to a pond. Areas on both sides of the waterway were terraced to slow runoff (KAN-1,790).



This parallel terrace system diverts runoff to grassed waterways (TEX 49,860).

and relaxation in the form of water sports. A dam built near the head of a gully or in a gully can store a large part of the runoff. The storage of water behind a dam reduces runoff downstream, and the reduction in runoff may permit natural revegetation to control erosion below the dam.

GRASSED WATERWAYS

Natural drainageways that are gullied or have an improper cross section can be improved to carry runoff safely by shaping and seeding to adapted species of grasses. This method is best suited to small and medium gullies that have small to medium drainage areas. If runoff lasts a short time and flows at nonerosive velocities, a properly shaped earth channel with good grass cover can carry the runoff from farm or field without causing erosion.

The velocity of flow should be about 3 to 6 feet a second, depending on the kind of soil and grasses used. The channel cross section should be broad and flat to keep the water spread uniformly over a wide area.

The depth of flow in a vegetated channel should be about 6 to 18 inches, depending on the slope, to keep the velocity within allowable limits. The slope of the channel—that is, the drop per unit of length—should not exceed 8 to 10 feet per 100 feet. Steeper

slopes usually cause the water to flow too fast to maintain good vegetative cover. Although there is no simple rule for determining the velocity of flow for a specific cross section and given slope, remember that, as the slope of the channel increases, the depth of the flow must decrease to maintain velocity within allowable limits.

Because vegetated channels cannot be constructed to precise dimensions, it is hard to maintain flow at shallow depths uniformly over wide areas. Therefore, the maximum width of waterways rarely should exceed 100 feet. If greater widths are required, divide the waterway into two parallel channels by constructing a small ridge of earth down the center of the proposed channel. Each waterway then is planned and built as one unit.

A waterway should not remain wet over long periods. Prolonged wetting can kill desirable vegetation; it softens the soil so that the vegetation is not effective in protecting the soil when stronger flow occurs. In northern states, runoff caused by melting snow can last a long time and must be considered in planning a waterway.

As the size of the drainage area increases, the duration and volume of flow increases. Waterways having drainage areas

This farm gully in South Carolina is being filled and shaped (SC-2,047).

larger than 150 to 200 acres usually are difficult to stabilize with vegetation.

Because natural waterways occur at elevations below the level of the adjoining field, seepage can cause the area to be wet and boggy. A subsurface drainage system may be required to remove excess ground water, dry up the waterway, and permit growing of vegetation.

■ **Shaping.** Gullies can be shaped to the desired size and form needed for the waterway with heavy earthmoving equipment or with power equipment available on a farm. Small gullies can be shaped with a tractor and plow. They can be filled gradually by plowing around the gully, starting near the edge of the bank and working the earth toward the center. A series of rounds, as used in building a terrace, by working the earth toward the center of the gully is recommended. Considerable working of the soil with a blade, scraper, or harrow may be required for a smooth, regular cross section. A little experience soon develops the plowing pattern that gives best results.

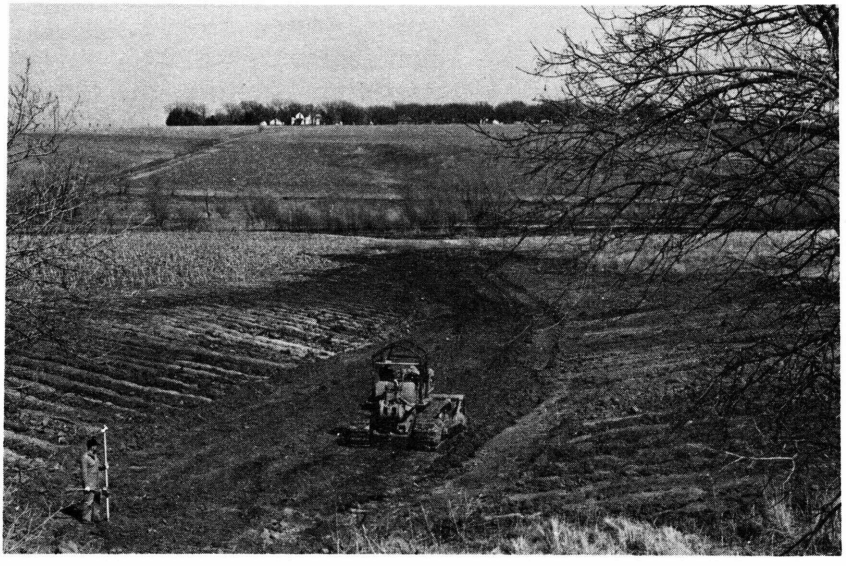
Heavy earthmoving equipment such as the track-type tractor, bulldozer, and the motor patrol can push the soil into the channel efficiently. The blade, an integral part of each unit, is suited to finishing operations. The heavy equipment packs the earth during filling and reduces settling to a minimum. Uncompacted earth settles; in deep gullies it might settle enough to distort the shape of the channel. Compacting also increases the erosion resistance of the earth in the channel, particularly important while vegetation is being established.

■ **Seeding.** You can prepare a firm seedbed when the gully has been shaped to the desired cross section. Fertilize the channel area because much of the topsoil may have been removed in filling operations. Seed the grass in the usual way; a good mulch cover helps to obtain a good stand. Your local SCS office or county agent can recommend the kinds of seeds, shrubs, trees, and fertilizers to use.

■ **Temporary diversion.** Because the channel can erode while grass is getting started, it may be necessary to build a temporary diversion to keep the water away from the waterway. Later, you can remove the diversion with a plow or scraper. If it is difficult to keep the water out of the channel, plant a companion crop and mulch the area to protect the soil until the grass is established.

Waterways used to carry water from terraces and diversions should be shaped and seeded and a good growth of vegetation established before terraces or diversions are built.

ABOVE: This gullied area used as a dump on a Nebraska farm was a source of pollution. BELOW: Shaped and covered with grass, this area is now part of a planned water-disposal system (NEB-1,833 and NEB-1,834).



STRUCTURES

■ **Determining need.** You may not be able to control medium to large gullies by vegetation alone or by diverting runoff. A careful study of individual site conditions must be made to determine where these practices no longer can satisfactorily control a gully and where structures must be used. If structures are required, you then need the help of an engineer to make a survey of site conditions to determine the kinds of structures needed and to insure an economical, safe job. Consult your local SCS office for information about design of structures.

The size and cost of structures required to control a gully or system of gullies vary widely. Improving waterways structurally is expensive because special equipment and skilled labor are often required. After the engineering survey, detailed plans must be made before construction begins. Standard plans have been developed for small structures, e.g., drop spillways and small drop inlets. You can build these small structures with technical assistance from SCS.

■ **Temporary structures.** Brush dams, long dams, wire dams, rock dams, and other temporary structures have been used to stabilize gullies while vegetation is being established. They require much

A combination gully-control and floodwater-retarding structure was built across this large gully as part of a watershed-protection program (MINN-1,734).

hand labor, are costly considering their short period of usefulness, and are of doubtful value. They are not recommended for these reasons.

■ **Permanent structures.** These structures are dams of various designs built of reinforced concrete, masonry, or earth with concrete or metal pipe spillways. They halt the advance of the vertical overfall at gully heads, stabilize the grade so the gully can be used as a waterway, and reduce the flow downstream if spillway storage is provided. In stabilizing the grade of a gully, structures trap sediment and eventually cause filling of the gully. To speed filling, the raw gully banks above and between structures can be shaped at the time of construction.

Because these structures must have a stable grade downstream, it is often necessary to build several in a reach of gully to stabilize it. The grade is stable when the channel is neither filling with sediment nor eroding. Stability depends on the kind and amount of vegetation in the channel, the kind of soil in the channel, and the velocity of the running water. A dam in a gully traps most of the sediment that would normally pass downstream. This loss of sediment may cause a grade that seems to be stable to start eroding, particularly if the channel is in sandy soil.

To prevent head erosion, a structure must be located so that the grade from the spillway crest to the ultimate lip of the gully does not exceed the silting grade. The safest procedure is to build the structure high enough to make the crest of the spillway level with the lip of the gully. The silting grade depends on the nature of the soil. It is best determined by investigating the grade of gullies in the area that appears stable. The silting grade should be kept within 6 inches per 100 feet.

The most important factor affecting the safety of a structure is the capacity of the spillway. The spillway should safely discharge the runoff from the heaviest rainfall that can be expected once in 25 to 100 years, depending on the importance of the dam. For example, if the dam is relatively small and inexpensive, the spillway should be designed to handle a flood that will occur once in 25 years.

The three basic structures used in stabilizing gullies are:

1. Drop inlets. This earth dam is ideally adapted for grade stabilization or control of advancing gully heads if a gully is more than 10 feet deep. It has a drop-inlet spillway of concrete or metal pipe with a vertical section called the riser on the upstream side of the dam. The riser is connected to a culvert or barrel passing through the earth dam. The crest of the riser is set at the elevation required to stabilize the grade upstream or to protect the gully head. Water must rise to the top of the riser before it discharges downstream.

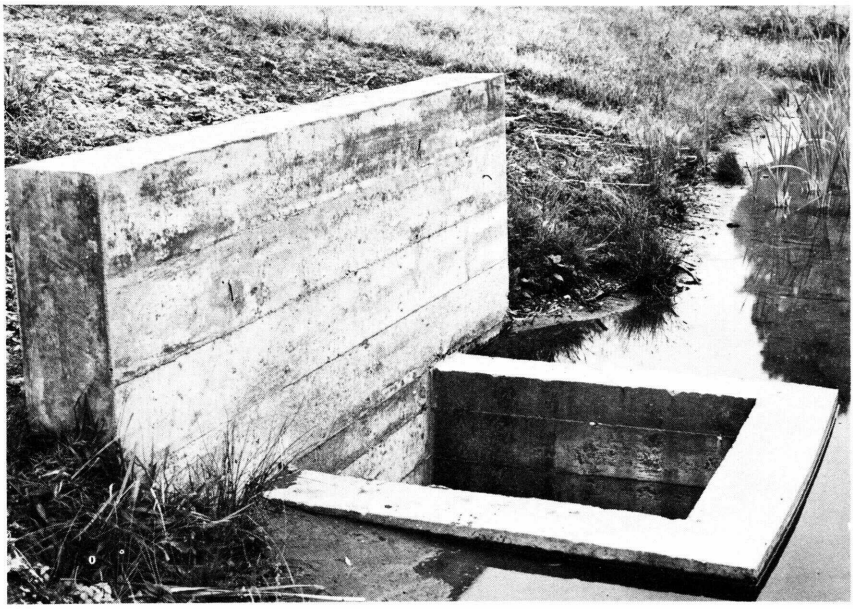
Usually an earth emergency spillway is built around one end of the dam to take the infrequent high floodflows. The spillway should be cut in the earth abutment and far enough from the earthfill to prevent the floodflow coming in contact with the downstream slope of the fill. The spillway grade should be flat enough so that, while vegetation is being established, the flowing water will not erode the spillway.

If the dam is built high enough to store some floodwater temporarily and an emergency spillway is installed, the size and cost of a drop inlet can be reduced.

The emergency spillway should have good vegetative cover, a uniform cross section, a gradual slope to the channel downstream, and no abrupt turns. It is primarily for the purpose of safeguarding the dam under extreme flow conditions. The emergency spillway should be enough higher than the crest of the drop inlet to permit the drop inlet to discharge at its rated capacity before the emergency spillway functions.

The outlet of the drop inlet is placed at or slightly above the elevation of the grade below the dam. A propped outlet is generally used. The pipe is extended below the toe of the dam and is supported by piling or a concrete pier. The support is placed 6 to 8 feet from the end of the pipe to protect it from the scour

This drop-inlet structure stabilizes a gully and collects sediment from a field below (CONN-97).



hole that will form. A propped outlet is inexpensive, and it can discharge water far enough downstream so as not to endanger the dam. If the grade lowers excessively downstream from the outlet, the outlet can be extended and lowered. A propped outlet permits installing dams at locations where the grade downstream is not considered completely stable.

A drop inlet with a propped outlet should not be built where the grade downstream averages more than 1 percent. For steeper grades, supporting dams should be built downstream to a point where the resultant grade is less than 1 percent. Standards for preparing the foundation and placing earthfill for drop inlets can be obtained from your local SCS office.

2. Drop spillways. Built of reinforced concrete, masonry, steel, aluminum, or sheet steel piling, drop spillways can be designed for almost any height, but are best suited to drops of 10 feet or less. The total storm runoff usually passes over the crest of the drop spillway. Emergency earth spillways are seldom used in connection with drop spillways.

Drop spillways require careful designing of the apron or floor, on which the water falls, to dissipate the energy before passing to the channel below. Improper apron design causes scour of the channel immediately below the structure. Excessive scour immediately downstream endangers the safety of a structure. Drop spillways, therefore, are used only at places where the grade downstream from the structure has been carefully studied and determined stable. Earthfills are used to connect the structures with the earth abutments.

3. Chutes. Chutes are used with earth dams to drop water farther than is ordinarily feasible with drop inlets and spillways. Built of reinforced concrete, chutes are constructed on foundations on solid ground or on fill that has been carefully compacted under controlled conditions. The chute is susceptible to movement because of frost action or other causes. Closely spaced expansion joints are required to relieve the structure of stress that would cause cracking. Chutes are individually designed to fit specific site conditions.

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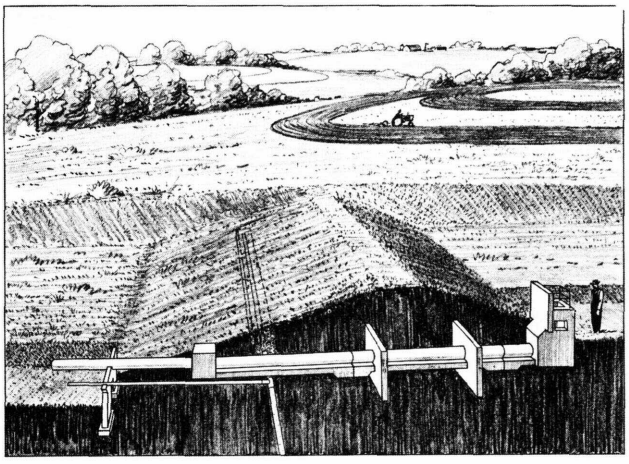
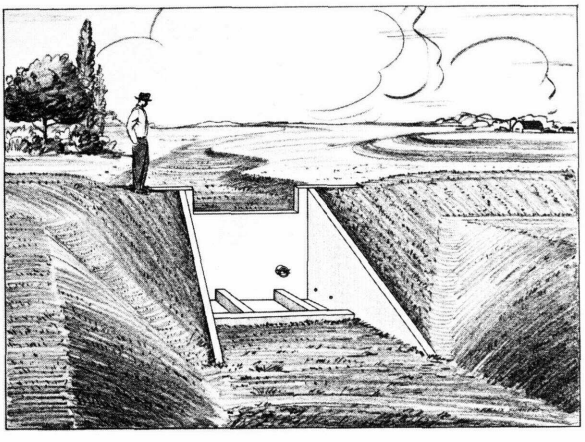
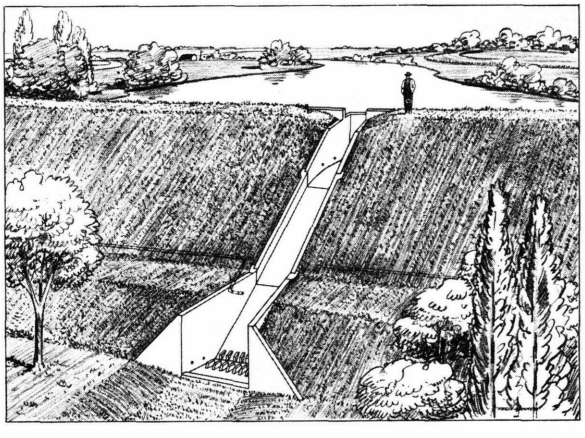
Drop inlet with a propped outlet built through an earthfill dam (SS-6).





BASIC STRUCTURES FOR STABILIZING GULLIES

Drop spillway built to stabilize the lower end of a grass waterway (SS-1).



Chute spillway in a fairly large earthfill dam (SS-5).

This worn-out bridge on an Iowa country road was replaced by a grade-control structure that stopped gully growth. The silt is stored above and kept from clogging the stream, road maintenance has been reduced, and an ugly gullied area has disappeared from view (IA-2,711A). See cover for the way it looks now (IA-2,711B).